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Attorney Docket No. GEMS8081.191

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re Application of : Peters, Robert D.

Serial No. : 10/707,433

Filed : December 12, 2003

For : Method and Apparatus to Correct Amplitude Modulation in  
Multi-Echo Magnetic Resonance Imaging

Group Art No. : 2859

Examiner : Fetzner, T.

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**CERTIFICATION UNDER 37 CFR 1.8(a) and 1.10**

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**APPLICANT'S SUMMARY OF TELEPHONE INTERVIEW**  
**OF NOVEMBER 11, 2005**

Dear Sir:

Responsive to the Examiner-Initiated Interview Summary mailed November 8, 2005,  
Applicant requests consideration of the following remarks.

**In the Claims**

What is claimed is:

1. (Previously Presented) A method comprising the steps of:
  - acquiring k-space data from multiple echoes in an echo train with a fast spin echo pulse sequence;
  - correcting the acquired k-space data for amplitude modulation effects in the fast spin echo pulse sequence; and
  - 2D Fourier transforming the corrected k-space data to form an image space from which an image is reconstructed.

2. (Previously Presented) The method of claim 1 wherein the step of correcting includes the steps of:

- acquiring at least one set of reference k-space data;
- determining a table of amplitude modulation correction values; and
- applying at least a portion of the table to the acquired k-space data.

3. (Previously Presented) The method of claim 2 further comprising the steps of acquiring at least one set of reference k-space data before and after acquisition of the k-space data.

4. (Previously Presented) The method of claim 2 further comprising the steps of acquiring at least one set of reference k-space data before acquisition of the k-space data and acquiring a second portion of the at least one set of reference k-space data after acquisition of the k-space data.

5. (Previously Presented) The method of claim 2 wherein the at least one set of reference k-space data includes non-phase encoded data.

6. (Previously Presented) The method of claim 2 wherein the steps of applying includes the steps of:

- multiplying each k-space view of the acquired k-space data by a correction value in a corresponding  $k_y$  location in the table; and

carrying out the steps of multiplying prior to transformation of the acquired k-space data from k-space to image space.

7. (Previously Presented) The method of claim 2 wherein the at least one set of reference data includes two sets of reference data, and further comprising the steps of averaging the two sets of reference data to determine the table of correction values.

8. (Previously Presented) The method of claim 5 wherein the at least one set of reference data represents a maximum achievable signal that the acquired phase encoded k-space data can attain.

9. (Previously Presented) The method of claim 1 wherein the k-space data is acquired via multiple receiver coils, and further comprising the steps of correcting for amplitude modulation effects in the k-space data from each receiver coil independently.

10. (Original) The method of claim 9 further comprising the steps of generating a combined image from corrected image data from each receiver coil.

11. (Previously Presented) An MRI apparatus comprising:  
a magnetic resonance imaging (MRI) system having a plurality of gradient coils positioned about a bore of a magnet to impress a polarizing magnetic field and an RF transceiver system and an RF switch controlled by a pulse module to transmit RF signals to an RF coil assembly to acquire MR images; and  
a computer programmed to:  
(A) acquire at least one set of reference MR data;  
(B) determine a table of amplitude modulation correction values from the reference MR data;  
(C) acquire MR data with a fast spin echo pulse sequence; and  
(D) modify the acquired MR data while the MR data is entirely in k-space by the table of amplitude modulation correction values to account for amplitude modulation effects in a fast spin echo pulse sequence played out to acquire the MR data.

12. (Original) The MRI apparatus of claim 11 wherein the computer is further programmed to acquire the at least one set of reference MR data from one or more discarded acquisitions played out one of prior to and after acquisition of the MR data.

13. (Original) The MRI apparatus of claim 11 wherein the computer is further programmed to acquire portions of the at least one set of reference MR data prior to and after acquisition of the MR data.

14. (Previously Presented) The MRI apparatus of claim 11 wherein the at least one set of reference MR data includes non-phase encoded data and the acquired MR data is modified while in k-space.

15. (Canceled)

16. (Original) The MRI apparatus of claim 11 wherein the RF coil assembly includes a phased array of receiver coils.

17. (Original) The MRI apparatus of claim 16 wherein the computer is further programmed to carry out acts (A)-(D) independently for each receiver coil.

18. (Original) The MRI apparatus of claim 11 wherein the computer is further programmed to generate an image space from the modified MR data.

19. (Previously Presented) A computer readable storage medium having a computer program to execute a fast spin echo pulse sequence stored thereon and representing a set of instructions that when executed by a computer causes the computer to:

acquire non-phase encoded MR data;  
acquire phase encoded MR data from multiple echoes;  
generate a set of amplitude correction values from the non-phase encoded MR data;

arrange the set of amplitude correction values in a table dimensionally equivalent to a k-space of phase encoded MR data; and

modify the phase encoded MR data by the non-phase encoded MR data to correct amplitude modulation between the multiple echoes by modifying each data point of k-space with a similarly positioned amplitude correction value.

20. (Original) The computer readable storage medium of claim 19 wherein the set of instructions further causes the computer to acquire the non-phase encoded MR data from a series of discarded acquisitions played out at least one of before and after acquisition of the phase encoded MR data.

21. (Original) The computer readable storage medium of claim 19 wherein the phase encoded data includes one of 2D and 3D MR data.

22. (Original) The computer readable storage medium of claim 19 wherein the non-phase encoded MR data represents a maximum achievable signal that the phase encoded MR data can attain.

23. (Canceled)

24. (Original) The computer readable storage medium of claim 19 wherein the set of instructions further causes the computer to amplitude correct acquired phased encoded MR data without increasing scan time.

25. (Original) The computer readable storage medium of claim 19 wherein the set of instructions further causes the computer to carry out a pre-scan of a subject and acquire the non-phase encoded MR data after the pre-scan but before acquisition of the phase encoded MR data.

26. (Original) The computer readable storage medium of claim 19 incorporated into a computer data signal embodied in a carrier wave that is uploadable/downloadable to an MR imaging system.

**REMARKS**

On November 1, 2005, Applicant, at the initiation of the Examiner, conducted an extensive telephone interview regarding the outstanding issues with respect to the above-captioned application. On November 8, 2005, the Examiner provided a written summary of that Interview. While the Examiner indicated that it was not necessary for the Applicant to provide written summary of that Interview; nevertheless, Applicant believes it necessary to provide a separate accounting of the Interview as the Examiner has mischaracterized portions of the Interview.

Two issues with respect to the claims were discussed in the Interview. First, the Examiner reiterated the position that claim 1 could be interpreted as calling for a pre-data acquisition correction technique. The Examiner attempted to explain the merits of reaching such a conclusion and sounded agitated (if not angered) by the undersigned's unwillingness to acquiesce to the Examiner's interpretation. While it is agreed that acquiescing would have been expedient; nevertheless, the Examiner's interpretation was illogical and misrepresented that called for in claim 1. The undersigned made repeated attempts to illustrate how the Examiner's interpretation of the claim was not supported by the language of the claim, but those attempts were met with repeated resistance.

The Examiner made repeated reference to the belief that the undersigned was presenting arguments that were not based on the clear (or at least, interpretative) meaning of the language of claim 1. Applicant's representative offered amendatory language for the Examiner to consider, but seeming unwilling to deviate from the intended goal of having the claim read as the Examiner wanted the claim to read, the Examiner dismissed Applicant's proposed amendment and reiterated that anything short of agreeing with the Examiner's amendment would result in a continued rejection of the claim.

In particular, the Examiner interpreted claim 1 as calling for a pre-data acquisition process whereby the fast spin echo train is corrected rather than the post-data acquisition, data correction technique clearly called for in the claim. Specifically, the second element of claim 1 calls for "correcting the acquired k-space data for amplitude modulation effects in the fast spin echo pulse sequence." The Examiner has interpreted this language as being directed to a corrective technique for correcting the fast spin echo pulse sequence. However, as Applicant has previously presented and reiterated by the undersigned in the Interview, it is clear that the acquired k-space data is being corrected, not the fast spin echo pulse sequence.

To further illustrate this point, the undersigned referred the Examiner to the first clause of claim 1 which calls for “acquiring k-space data from multiple echoes in an echo train with a fast spin echo pulse sequence.” While Applicant agrees that elements of a method claim may be interpreted to occur in an order different from the order in which the elements are listed; nonetheless, the language is clear that k-space data is acquired and that the “acquired k-space data” is corrected. Therefore, regardless of the order in which the Examiner wishes to place the claimed steps, the acquired k-space data is corrected. At no point in the claim language or in any possible order of the claimed method steps is the pulse sequence corrected. In short, as repeatedly pointed out to the Examiner, the k-space data that has been acquired is corrected – not the pulse sequence.

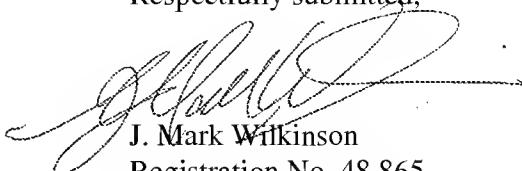
To expedite prosecution and appease the Examiner’s interpretation that claim 1 calls for a pre-data acquisition correction technique, the undersigned proposed that the term “then” be placed after “sequence” in the first element in claim 1. Notwithstanding this olive branch, the Examiner dismissed the gesture and reiterated that anything short of accepting the Examiner’s proposed amendment of changing “in” to “from” in the fourth line of claim 1 was going to be inadequate. The undersigned was unwilling to accept the Examiner’s mandate as it was not only unnecessary, but did not properly reflect the invention. The invention is properly defined by the language currently present in claim 1 and despite the Examiner’s exhaustive efforts to draft the claim as the Examiner believes it should read, Applicant is entitled to define the invention as desired. Admittedly, the Examiner may give a broad interpretation of the claim, but that interpretation is bound by the plain meaning of the claim language and logic. Thus, it is clear that claim 1, as currently written, is directed to a post-data acquisition correction process.

Second, the Examiner also sought amendatory language for “k-space data” as, according to the Examiner, it is necessary for the modifier “MR” to be used to clarify that the k-space data corresponds to data acquired using magnetic resonance. Again, in the Interview, the Examiner was reminded that Applicant reserves the right to define the invention and, notwithstanding the Examiner’s desires, Applicant is unwilling to amend to claims unless needed to overcome a statutory rejection. The undersigned conveyed as much and invited the Examiner to not limit a search of the invention to “MR k-space data” and if the art necessitated the Examiner’s proposed amendment, Applicant would be willing, upon a specific showing that such was needed, to amend claims 1-11 to call for “MR k-space data”

rather than "k-space data". This was again met with vexation and the Examiner quickly terminated the Interview by indicating that an Advisory Action would be forthcoming.

The undersigned thanked the Examiner for the time and cooperation in resolving the outstanding issues and reiterated a willingness to amend the claims as suggested by the Examiner upon a showing that the art of record necessitates such amendments to define the invention over the art of record.

Respectfully submitted,



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